CLAIMS

[Claim(s)]
[Claim 1] Change of the electric resistance of the resistance element formed in said micro structure detects the mechanical deformation based on an operation of the acceleration of the micro structure manufactured according to a micro-processing process. In the acceleration sensor currently made that the sense and magnitude of acceleration should be detected said micro structure Four beams which make the shape of 2 straight lines which connects the weight object prepared in the frame part and the abbreviation core of said frame part, and said weight object and said frame part, and crosses, Were formed successively by said weight object in the condition of inserting in the space surrounded by 2 in said beam, and the inner skin of said frame part. When it sees from the perpendicular upper part based on [said] the micro structures to the 1st principal plane which has at least one auxiliary weight object, and includes said frame part front face Said frame part seen from said perpendicular upper part at the time of each die length of said four beams being the same, and making it rotate 90 degrees centering on the 1st principal plane core of said micro structure, When the map of said weight object and said four beams becomes the same as the original map and makes the principal plane of the opposite side of the 1st principal plane of said micro structure the 2nd principal plane, the 1st principal plane and the 2nd principal plane The same plane view [in / when it sees from the perpendicular upper part based on / said / the micro structures / said weight object and said auxiliary weight object] -- abbreviation -- It is the same thickness. furthermore, thickness with same said weight object and said auxiliary weight object — having -- and said frame part and abbreviation — It is the acceleration sensor characterized by being formed so that each principal plane part of said weight object and said auxiliary weight object may estrange slightly and may be held to said package, in case each principal plane faces a package, and having formed said resistance element on said beam.
[Claim 2] spacing of said weight object and inner skin of said frame part, and spacing of said auxiliary weight object and said beam -- abbreviation — the same acceleration sensor according to claim 1.
[Claim 3] It is the acceleration sensor according to claim 1 or 2 to which said frame part is made [center section / of each side of said frame part / nothing, said weight object, and / abbreviation] in the square configuration that said beam should connect, and said auxiliary weight object makes the shape of the square pole.
[Claim 4] It is the acceleration sensor according to claim 1 or 2 to which the triangular area which consists of two sides into which said frame part inserts nothing, and the oblique side longer than the beam width to a corner and said corner of said frame part for a square configuration is prepared, said beam is connected to in the abbreviation center section of the oblique side of said triangular area, and said auxiliary heavy water object makes the shape of the triangle pole.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the acceleration sensor which detects the acceleration of-dimensional [2] or the direction of three dimensions using the resistance element which shows an acceleration sensor, especially a piezoresistance condenser.
[0002]
[Description of the Prior Art] Drawing 5 is the perspective view showing the acceleration sensor of the conventional piezoresistance detection mold, and three in drawing is the micro structure. The micro structure means a semi-conductor

substrate or a micro machine manufactured according to a micro-processing process.
[0003] The micro structure 3 has the rectangular frame part 31, and the cylinder-like weight object 32 is formed in the core of a frame part 31. This weight object 32 is connected with the center section of each side of a frame part 31 by beams 33, 33, 33, and 33. The resistance elements Ry1-Ry4 for detecting the acceleration component of Y shaft orientations are still more nearly parallel to the X-axis, and the resistance elements Rz1-Rz4 for detecting the acceleration component of Z shaft orientations on the shaft in the near are allotted to the beams 33 and 33 by which this and the resistance elements Rx1-Rx4 for detecting the acceleration component of X shaft orientations cross at right angles by the beams 33 and 33 which make the shape of a straight line.
[0004] The drawing 6 ****7 is the circuit diagram showing the bridge circuit formed of the resistance element in an acceleration sensor, drawing 6 is a circuit diagram about Rx1-Rx4, and Ry1-Ry4, and drawing 7 is a circuit diagram about Rz1-Rz4. When acceleration is added, it originates in acceleration and external force acts on the weight object 32, the weight object 32 is displaced from an orientation, mechanical distortion produced with this variation rate is absorbed by the mechanical deformation of beams 33, 33, 33, and 33, and the electric resistance of the resistance element R formed on this changes. Consequently, the balance of the bridge circuit shown in drawing 6 R> 6 collapses, and an electrical potential difference Vout is detected. Here, the weight object 32 receives the moment to the acceleration of X (Y) shaft orientations, about Z shaft orientations, a changed part is offset and a part for the piezoresistance change about X (Y) shaft orientations is not outputted, although added and outputted. On the other hand, to the acceleration of Z shaft orientations, the weight object 32 is displaced perpendicularly, and a part for piezoresistance change is added and outputted about Z shaft orientations, and is not offset and outputted about X (Y) shaft orientations.
[0005]
[Problem(s) to be Solved by the Invention] In order to make inertial force increase, when the weight object 32 was enlarged in the case of the acceleration sensor of the piezoresistance detection mold of drawing 5 mentioned above, there was a problem that a beam 33 became short, distortion of a beam 33 became small relatively, and the detection sensitivity by the piezoresistance became small relatively. This had become the failure which miniaturizes an acceleration sensor.
[0006] While being able to enlarge weight combined with the weight object by making this invention in view of this situation, and having an auxiliary weight object, the die length of a beam can be lengthened and detection sensitivity can be raised from the conventional acceleration sensor, and frequency characteristics and shock resistance are good, and it aims at offering the acceleration sensor which can be miniaturized.
[0007] moreover, this invention — spacing of an auxiliary weight object and the inner skin of a frame part, and spacing of an auxiliary weight object and a beam — abbreviation — while acceleration is detectable with a sufficient precision in the X-axis and Y shaft orientations by making it the same, it aims at offering the acceleration sensor which can enlarge magnitude of an auxiliary weight object effectively.
[0008] And by constituting a beam that a weight object and the abbreviation center section of each side of a frame part should be connected, respectively, and making an auxiliary weight object into the shape of the square pole, this invention can detect acceleration with a sufficient precision in the X-axis and Y shaft orientations further, and aims at offering the acceleration sensor which can enlarge weight.
[0009] Furthermore, by this invention's preparing the triangular area which consists of an oblique side longer than beam width and two sides which sandwich a corner, connecting a beam to the corner of a frame part in the abbreviation center section of the oblique side of a triangular area, and making an auxiliary weight object into the shape of the triangle pole While long beam length can be taken, detection sensitivity improves, stress concentration does not arise but endurance improves, distortion which starts in the beam width direction of a piezoresistance becomes uniform, and it aims at offering the acceleration sensor whose sensibility property improves.
[0010]
[Means for Solving the Problem] The acceleration sensor of the 1st invention detects the mechanical deformation based on an operation of the acceleration of the micro structure manufactured according to a micro-processing process by change of the electric resistance of the resistance element formed in said micro structure. In the acceleration sensor currently made that the sense and magnitude of acceleration should be detected said micro structure Four beams which make the shape of 2 straight lines which connects the weight object prepared in the frame part and the abbreviation core of said frame part, and said weight object and said frame part, and crosses, Were formed successively by said weight object in the condition of inserting in the space surrounded by 2 in said beam, and the inner skin of said frame part. When it sees from the perpendicular upper part based on [said] the micro structures to the 1st principal plane which has at least one auxiliary weight object, and includes said frame part front face Said frame part seen from said perpendicular upper part at the time of each die length of said four beams being the same, and making it rotate 90 degrees centering on the 1st principal plane core of said micro structure, When the map of said weight object and said four beams becomes the same as the original map and makes the principal plane of the opposite side of the 1st principal plane of said micro structure the 2nd principal plane, the 1st principal plane and the 2nd principal plane The same plane view [in / when it sees from the perpendicular upper part based on / said / the micro structures / said weight object and said auxiliary weight object] — abbreviation — It is the same thickness. furthermore, thickness with same said weight object and said auxiliary weight object — having — and said frame part and abbreviation — It is characterized by being formed so that each principal plane part of said weight object and said auxiliary weight object may estrange slightly and may be held to said package, in case each principal plane faces a package, and having formed said resistance element on said beam. Here, as for said four beams, intersecting perpendicularly is desirable.
[0011] In the 1st invention, it has the auxiliary weight object, and since weight combined with the weight object can be enlarged, the detection sensitivity of acceleration improves from the conventional acceleration sensor. And a weight object can be made small by enlarging sum total weight with an auxiliary weight object, consequently the die length of a beam can be lengthened, and the detection sensitivity by the piezoresistance can be raised. Therefore, it becomes possible to

miniaturize an acceleration sensor. Moreover, since an auxiliary weight object has a damping function, frequency characteristics are also improvable. Furthermore, since a frame part functions as a stopper even if it displaces an auxiliary weight object, shock resistance is good. and etching by RIE mentioned later — the inner skin of a weight object, an auxiliary weight object, and a frame part — abbreviation — since a perpendicular side face can be acquired, weight can be enlarged effectively. thereby — the plane view of the 1st principal plane of the weight object of the micro structure, and an auxiliary weight object, and the 2nd principal plane — abbreviation — it becomes the same. in addition, a weight object and an auxiliary weight object — a frame part and abbreviation — although it is the same thickness, since it has made in order to prepare a clearance between packages, the engine performance does not worsen with a package

[0012] the acceleration sensor of the 2nd invention — the 1st invention — setting — spacing of said auxiliary weight object and inner skin of said frame part, and spacing of said auxiliary weight object and said beam — abbreviation — it is characterized by the same thing. In the 2nd invention, while acceleration is detectable with a sufficient precision in the X-axis and Y shaft orientations, a tooth space can be used effectively and magnitude of an auxiliary weight object can be enlarged effectively.

[0013] It is characterized by having made that, as for the acceleration sensor of the 3rd invention, said beam should connect nothing, said weight object, and the abbreviation center section of each side of said frame part for a square configuration in the 1st or 2nd invention, as for said frame part, and said auxiliary weight object making the shape of the square pole. In the 3rd invention, since the auxiliary weight object is arranged at the X-axis and a Y-axis, and parallel, acceleration can be detected with a still more sufficient precision in the X-axis and Y shaft orientations and an auxiliary weight object makes the shape of the square pole, weight can be enlarged.

[0014] The triangular area which the acceleration sensor of the 4th invention becomes from two sides into which said frame part inserts the oblique side longer than beam width to the corner of nothing and said frame part and said corner for a square configuration in the 1st or 2nd invention is prepared, said beam is connected in the center section of the oblique side of said triangular area, and said auxiliary weight object is characterized by making the shape of the triangle pole. In the 4th invention, since long beam length can be taken, detection sensitivity improves. In addition, in a triangular area, since it constituted so that the include angle of the side face of a beam and the inner skin of a frame part to make might not become an acute angle, stress concentration does not arise but endurance improves. Moreover, distortion which starts in the beam width direction of a piezoresistance becomes uniform, and a sensibility property improves.

[0015]

[Embodiment of the Invention] Hereafter, this invention is concretely explained based on the drawing in which the gestalt of the operation is shown. Drawing 1 is the perspective view which looked at the sensor section of the acceleration sensor of the piezoresistance detection mold concerning the gestalt 1 of operation of this invention from the front-face (1st principal plane) side, drawing 2 is the perspective view seen from the rear-face (2nd principal plane) side, and one is the sensor section which consists of a SOI (Silicon On Insulator) substrate as the micro structure among drawing.

[0016] The sensor section 1 has the rectangular frame part 11, and the cylinder-like weight object 12 is formed in the core of a frame part 11. This weight object 12 is connected by the center section of each side of a frame part 11, and beams 13, 13, 13, and 13. The resistance elements Ry1-Ry4 for detecting the acceleration component of Y shaft orientations are parallel to the X-axis, and the resistance elements Rz1-Rz4 for detecting the acceleration component of Z shaft orientations on the shaft in the near are allotted to the beams 13 and 13 by which this and the resistance elements Rx1-Rx4 for detecting the acceleration component of X shaft orientations cross at right angles by the beams 13 and 13 which make the shape of a straight line. And the square pole-like auxiliary weight objects 14, 14, 14, and 14 are formed successively on the weight object 12 in the condition of inserting in the space surrounded by beams 13 and 13 and the inner skin of a frame part 11.

[0017] The die length of length and width is [2.5mm and thickness] 566 micrometers, respectively, and the width of face of a frame part 11 of the dimension of the sensor section 1 is 500 micrometers. And for 550 micrometers and width of face, the length of 70 micrometers and the auxiliary weight object 14 and the horizontal die length is [the diameter of the weight object 12 / the die length of 400 micrometers and a beam 13 / spacing of 615 micrometers, the auxiliary weight object 14, and the inner skin of a beam 13 and a frame part 11] 50 micrometers, respectively.

[0018] The bridge circuit formed of the resistance element in an acceleration sensor is the same as that of drawing 5 and drawing 6 which were mentioned above, and drawing 5 and the circuit diagram about the same, and Rz1-Rz4 of the circuit diagram about Rx1-Rx4, and Ry1-Ry4 are the same as that of drawing 6 R> 6. When acceleration is added, it originates in acceleration and external force acts on the weight object 12 and the auxiliary weight object 14, the weight object 12 and the auxiliary weight object 14 are displaced from an orientation, mechanical distortion produced with this variation rate is absorbed by the mechanical deformation of beams 13, 13, 13, and 13, and the electric resistance of the resistance element R formed on this changes. Consequently, the balance of the bridge circuit shown in drawing 5 R> 5 and drawing 6 collapses, and an electrical potential difference Vout is detected. Here, the weight object 12 and the auxiliary weight object 14 receive the moment to the acceleration of X (Y) shaft orientations, about Z shaft orientations, a changed part is offset and a part for piezoresistance change of X (Y) shaft is not outputted, although added and outputted. On the other hand, to the acceleration of Z shaft orientations, the weight object 12 and the auxiliary weight object 14 change perpendicularly, and for this reason, a part for piezoresistance change is added and outputted about Z shaft orientations, and is not offset and outputted about X (Y) shaft orientations.

[0019] Next, the manufacture approach of the sensor section 1 is explained. Drawing 3 is the sectional view showing the SOI substrate which constitutes the sensor section 1. This SOI substrate is SiO2 with a thickness [as the Si layer 15 with a thickness of 560 micrometers and an embedding oxide film] of 1 micrometer. It consists of three layers of a layer 16 and the Si layer 15 with a thickness of 5 micrometers. First, the resistance elements Rx1-Rx4 for detecting the acceleration component of X shaft orientations are formed in the predetermined location corresponding to the beams 13 and 13 on the straight line in which the back is formed. The resistance elements Rz1-Rz4 for detecting the acceleration component of Z

shaft orientations are formed on the shaft which is parallel to the X-axis and is in the near about the resistance elements Ry1-Ry4 for detecting the acceleration component of Y shaft orientations in the predetermined location corresponding to the beams 13 and 13 which intersect perpendicularly with this. Next, the front face of a SOI substrate to SiO2 It etches by Si deep RIE (reactive ion etching) to a layer 16, and the weight object 12, beams 13, 13, 13, and 13, and the auxiliary weight objects 14, 14, 14, and 14 are formed. And a rear face to SiO2 Si deep RIE performs the Fukahori ** etching to a layer 16, and the weight object 12 and the auxiliary weight objects 14, 14, 14, and 14 are formed. To the last, it is SiO2. By etching a layer 16, the weight object 12, beams 13, 13, 13, and 13, and the auxiliary weight objects 14, 14, 14, and 14 are released, and it considers as movable structure.

[0020] The acceleration sensor concerning the gestalt of operation of this invention constituted as mentioned above has the auxiliary weight object 14, and since it can enlarge weight combined with the weight object 12, its detection sensitivity of acceleration improves as compared with the conventional acceleration sensor. And magnitude of the weight object 12 can be made small by making heavy sum total weight with the auxiliary weight object 14, consequently the die length of a beam 13 can be lengthened, and the detection sensitivity by the piezoresistance can be raised. Therefore, the miniaturization of an acceleration sensor is attained. To the size of the chip as the sensor section having been [5.0x5.0 (mm) and the dimension of the conventional acceleration sensor] 14.0x11.4x5.5 (mm), the size of a chip is miniaturized with 2.5x2.5 (mm), and, as for the acceleration sensor of this invention, the dimension is miniaturized with 5.0x5.0x5.0 (mm).

[0021] Moreover, since the auxiliary weight object 14 has a damping function, frequency characteristics are also improvable. Furthermore, since it stops at the inner skin of a frame part 11 even if the auxiliary weight object 14 is approaching with the frame part 11 and it displaces greatly, shock resistance is good. And the yield of manufacture also improves and it is checked that the manufacturing cost has decreased sharply.

[0022] In addition, in the gestalt of said operation, it has made that four beams 13 should connect the weight object 12 and the center section of each side of a frame part 11, and although it is explaining per when the weight object 12 makes the shape of a cylinder and nothing and the auxiliary weight object 14 make the shape of the square pole, it is not limited to this. Four beams 13 may be constituted that the weight object 12 and a frame part 11 should be connected in the shape of the diagonal line, and a cylinder and a base can also choose the configuration of the weight object 12 and the auxiliary weight object 14 from various configurations, such as multiple columns, such as a pillar-shaped object which is an ellipse form, the triangle pole, and the square pole.

[0023] Drawing 4 is the top view showing the acceleration-sensor section of this invention which has arranged four beams as the example in the shape of the diagonal line. The same sign has shown the same part as drawing 1 among drawing. In this acceleration sensor, the triangular areas 17, 17, 17, and 17 which consist of an oblique side longer than the width of face of a beam 13 and two sides which sandwich a corner are formed in each corner of the inner skin of a frame part 11, and the center section of the oblique side of this triangular area 17 and the square pole-like weight object 12 are connected by the beam 13. By the triangular area 17, a frame part 11 makes the shape of an octagon. In this acceleration sensor, beam length can be lengthened, in the X-axis and Y shaft orientations, acceleration can be detected more with a sufficient precision, and weight of the auxiliary weight object 14 can be enlarged. Moreover, since distribution of distortion of the cross direction of the beam 13 of a resistance element becomes uniform while endurance improves, since said triangular area 17 is minded, and the side face of a beam 13 and the inner skin of a frame part 11 do not make an acute angle but stress concentration is lost, a sensibility property improves more.

[0024] moreover, the gestalt of said operation — setting — spacing of the auxiliary weight object 14 and the inner skin of a frame part 11, and spacing of the auxiliary weight object 14 and beams 13 and 13 — abbreviation — although it is explaining per when it is made the same, it is not limited to this. however, said spacing — abbreviation — the direction made the same can detect acceleration with a sufficient precision in the X-axis and Y shaft orientations, can use a tooth space effectively, and can enlarge magnitude of the auxiliary weight object 14 effectively.

[0025] What is necessary is not to be limited to this, although it is explaining per when it has the auxiliary weight object 14 or four 24, and just to have the auxiliary weight object 14 or at least one 24 in the gestalt of said operation. However, the auxiliary weight object 14 has arranged at least two to the symmetry, and balance is [direction] good and it is more good.

[of detection sensitivity]

[0026]

[Effect of the Invention] As mentioned above, as explained in full detail, in this invention, it has the auxiliary weight object, and since weight combined with the weight object can be enlarged, the detection sensitivity of acceleration improves from the conventional acceleration sensor. And magnitude of a weight object can be made small by enlarging sum total weight with an auxiliary weight object, consequently the die length of a beam can be lengthened, and the detection sensitivity by the piezoresistance can be raised. Therefore, it becomes possible to miniaturize an acceleration sensor. Moreover, since an auxiliary weight object has a damping function, frequency characteristics can also be made to improve. Furthermore, since a frame part functions as a stopper even if it displaces an auxiliary weight object, shock resistance is good.

[0027] moreover, this invention — setting — spacing of an auxiliary weight object and the inner skin of a frame part, and spacing of an auxiliary weight object and a beam — abbreviation — since it similarly constitutes, while acceleration is detectable with a sufficient precision in the X-axis and Y shaft orientations, a tooth space can be used effectively and magnitude of an auxiliary weight object can be enlarged effectively. Consequently, a manufacture yield can improve and a manufacturing cost can be reduced.

[0028] Furthermore, in this invention, since the auxiliary weight object is arranged at the X-axis and a Y-axis, and parallel, acceleration can be detected with a still more sufficient precision in the X-axis and Y shaft orientations and an auxiliary weight object makes the shape of the square pole, the weight can be enlarged.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the perspective view which looked at the sensor section of the acceleration sensor of the piezoresistance detection mold concerning the gestalt of operation of this invention from the front-face side.
[Drawing 2] It is the perspective view which looked at the sensor section of the acceleration sensor of the piezoresistance detection mold concerning the gestalt of operation of this invention from the rear-face side.
[Drawing 3] It is the sectional view showing the SOI substrate which constitutes the sensor section.
[Drawing 4] It is the top view showing the sensor section of the acceleration sensor of other piezoresistance detection molds of this invention.
[Drawing 5] It is the perspective view showing the acceleration sensor of the conventional piezoresistance detection mold.
[Drawing 6] It is the circuit diagram showing the bridge circuit formed of the resistance element in an acceleration sensor.
[Drawing 7] It is the circuit diagram showing the bridge circuit formed of the resistance element in an acceleration sensor.
[Description of Notations]
1 Sensor Section
11 Frame Part
12 Weight Object
13 Beam
14 Auxiliary Weight Object

[Translation done.]

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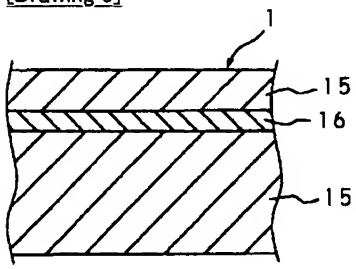
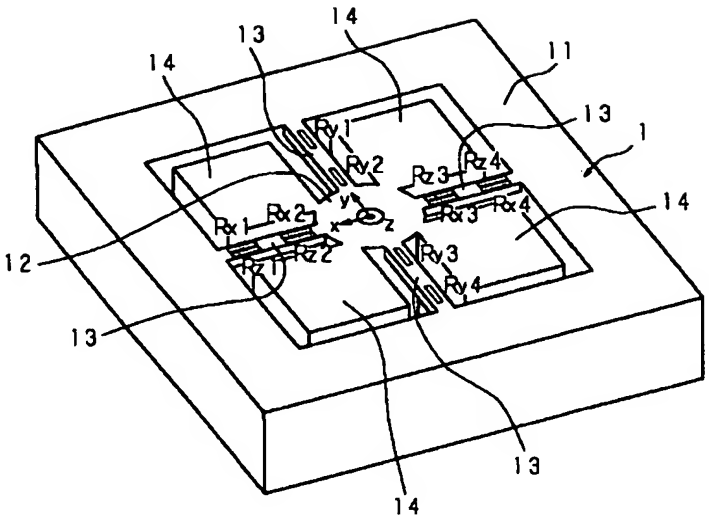
DRAWINGS

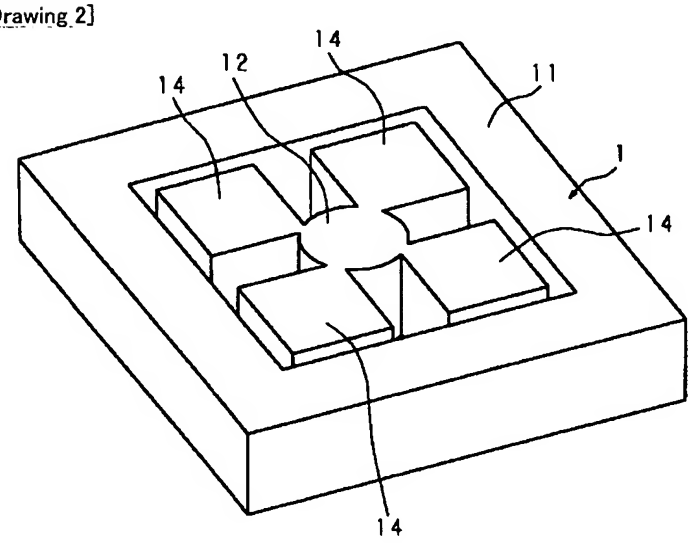
[Drawing 3]



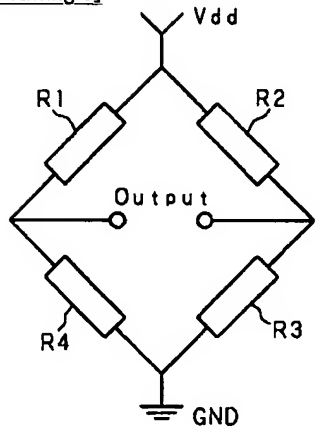
[Drawing 1]



[Drawing 2]

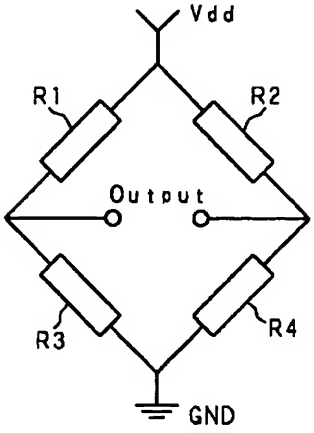


[Drawing 6]



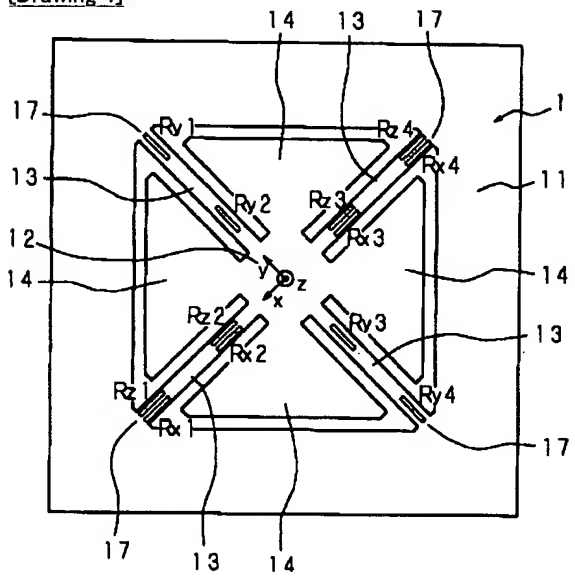
$$Vout = \left(\frac{R3}{R2+R3} - \frac{R4}{R1+R4} \right) Vdd$$

[Drawing 7]

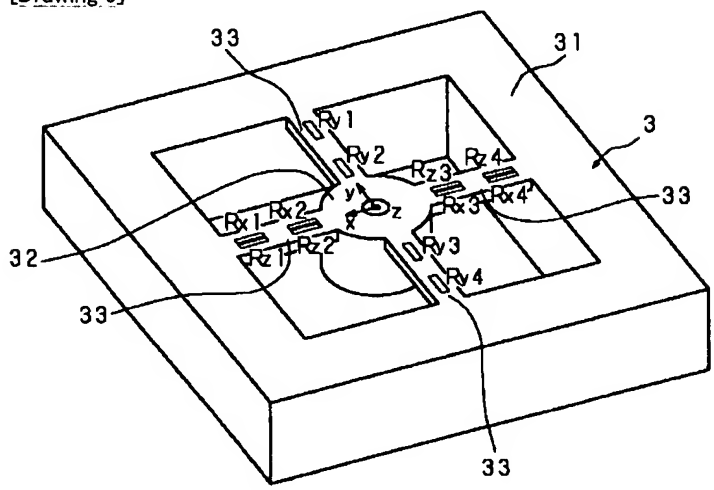


$$Vout=\left(\frac{R3}{R1+R3}-\frac{R4}{R2+R4}\right)Vdd$$

[Drawing 4]



[Drawing 5]



[Translation done.]